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(71) Applicant
Aesculap-Werke Aktiengesellschaft vormals Jetter & Scheerer
Postfach 40
D-7200 Tuttlingen
W Germany
(72) Inventors
Thomas Stuhler
Albert Helse
(74) Agents
Withers & Rogers

(54) Fracture fixing appliance

(57) An external clamping device for holding together bones or parts of bones (20, 21, 22) has links or joints (24, 25, 28) each comprising two or more link members (31a, 31b) with mating flat surfaces in which are spaced longitudinal bores parallel to such surfaces for receiving bone rods or nails (23, 27) and connecting rods (26), and also having transverse bores to receive screws for clamping the link members (31a, 31b) together to hold the various rods. The links or joints (24, 25, 28) can hold the rods at various angles and in various arrangements.

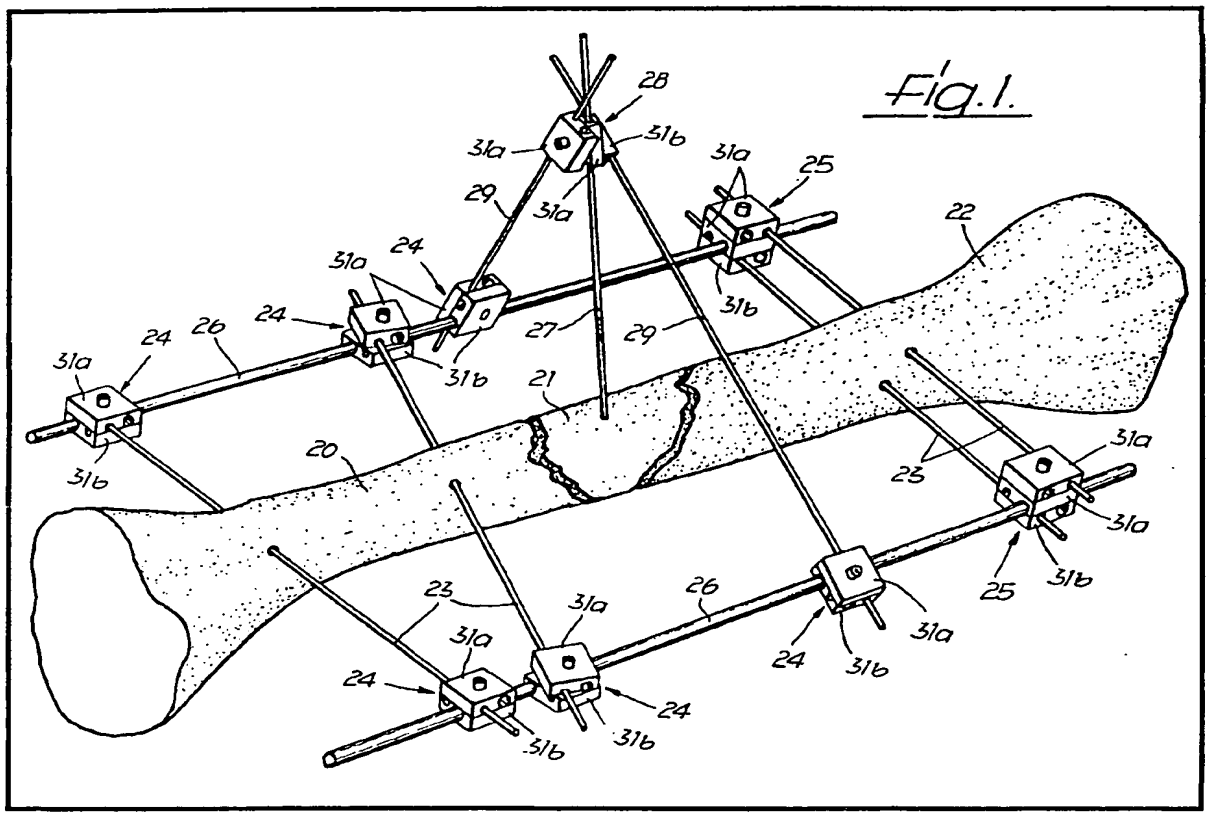

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Fig.2.

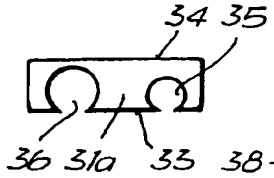


Fig.3.

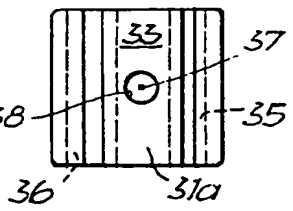


Fig.4.

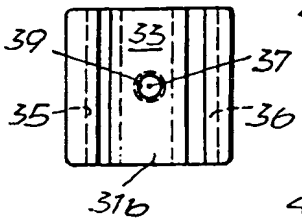


Fig.5.

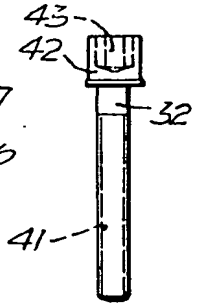


Fig.6.

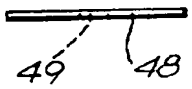


Fig.7.

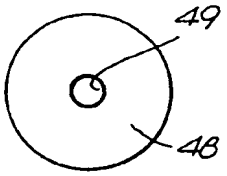


Fig.9.

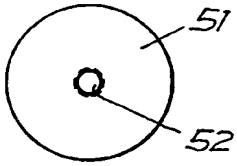


Fig.8.

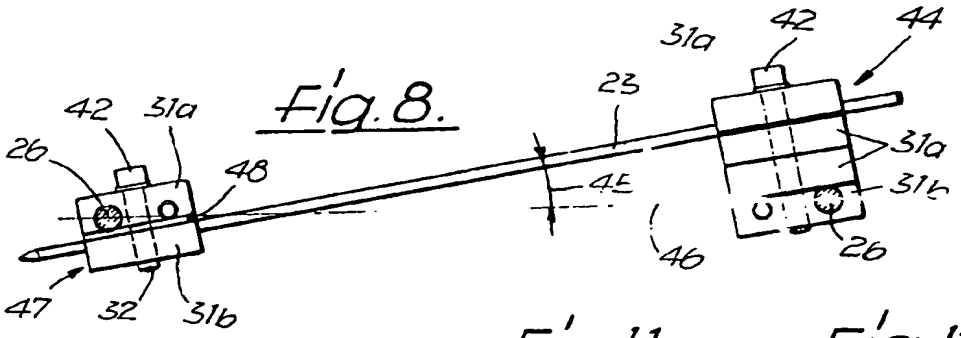


Fig.11.

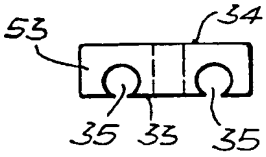


Fig.12.

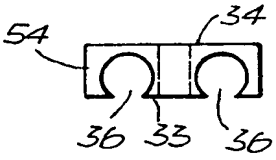


Fig.10.

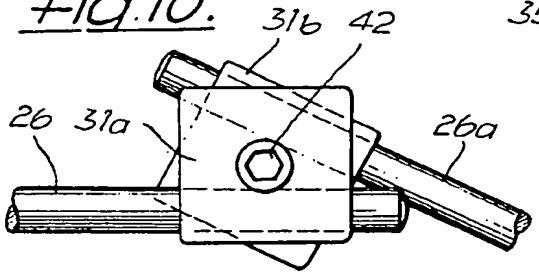
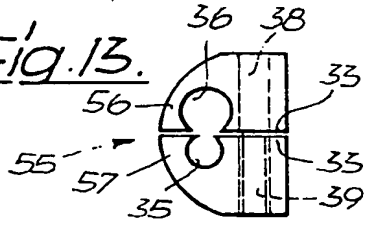


Fig.13.



SPECIFICATION

External clamping device for holding together bones or parts of bones

This invention relates to an external clamping device for holding together bones or bone parts by means of rods which are in the form of bone nails, bone screws or connecting rods, held together by multimembered joints which have bores for the rods, and in which bores the rods can be fixed, for example by screws.

The bone nails used for this purpose are also known as "Steinmann pins" and are designed to be introduced into transverse bores in a bone or bone part. The bone screws, known as "Schanz's screws", generally have the same diameter as the bone nails and have a screwthread at one end by which they can be screwed into a bone or bone part. By "holding together bones or bone parts" is meant quite generally both fixing and compression and traction of bone parts, i.e. the fixing of bones for stiffening joints and the fixing, compression and traction of osteotomies. External clamping devices are generally used in cases where great care must be taken of the surrounding soft tissue when reducing bone parts, as for example if an accident results not only in a broken bone but also in severe injuries to the surrounding soft tissue so that they must not be placed in a plaster cast. Another application is in readjustment after osteotomies.

Since an external clamping device must be adjusted to various conditions, the joints must allow for a versatile connection of the rods. This results in a complicated construction of the joints, which makes their manufacture relatively expensive. Due to their complicated construction, known clamping devices are also complicated for an operator to handle, particularly since the complicated construction makes it difficult to see at a glance all the possible ways of assembling a clamping device.

It is an object of the invention to provide an external clamping device for holding together bones or bone parts, which device can be adapted spatially to various surgical possibilities and can be readily understood and handled by an operator, and which is also of simple construction, whereby the difficulty in manufacture and hence the cost of the clamping device can be reduced.

According to this invention, there is provided an external clamping device for holding together bones or bone parts with rods formed as bone nails, bone screws or connecting rods, held together by multi-membered links which have bores for the rods, and in which bores the rods can be fixed, wherein (i) a set of link members of first and second types is provided to form several links, (ii) each link member has at least one flat external surface, at least one longiudinal bore for a rod, the axis of which bore is parallel to and along the flat external surface at a distance therefrom which is less than the radius of the bore, and a transverse bore which is substantially perpendicular to the flat external surface and (iii) a link comprises a link member of the second type and at least one link member of the first type which can be pressed together by clamping means with their flat external surfaces facing each other so that rods inserted in the longitudinal bores have their circumferential surfaces partly projecting from the flat lateral surfaces of the link members and are clamped tightly in the longitudinal bores.

Since the longitudinal axes of all the longitudinal bores are situated at a distance from the plane external surfaces which is only slightly smaller than the radius of the longitudinal bores, only one link member is required for fixing the various rods. A link can therefore be produced from only two link members and for example a single headscrew as the clamping means, so that a less cluttered and more easily comprehended link is obtained.

If the clamping means is in the form of a headscrew and the set of link members includes for each link one membver in which the transverse bore has an internal thread for the head-screw, the two link members differ only in that one has a thread in its transverse bore while the other has a smooth transverse bore. This also simplifies manufacture of the device and, when headscrews of differing lengths are used, it is possible to assemble links from any number of link members so that a variety of links can be obtained from only two types of link members, namely those with a smooth transverse bore and those with a threaded bore. The possibilities arising from this are clear, readily comprehensible and uncomplicated, since the link members are otherwise identical.

One advantage is that simply by suitable choice of the length of a headscrew it is also possible to use any link member as a spacer between two link members used for fixing rods, with the result that the rods can not only be shifted axially parallel to the plane which is perpendicular to the headscrew and adjusted in their angle to each other, but can be shifted relatively to each other in the direction of the axis of the headscrew, according to whether one or more link members are introduced between the two end members. This is particularly important where a link is to be used to fix bone nails.

An advantageous construction is obtained by arranging two parallel longitudinal bores in the plane lateral surface, equidistant from the transverse bore and on opposite sides thereof. Since two longitudinal bores are formed in the plane lateral surface of each link member, one

may be designed to receive a bone nail or screw and the other to receive a connecting rod. This enables each link member to be used for fixing a longitudinal connecting rod or a bone nail or screw. In other words, it is not necessary to provide different link members for the various rods. This has the advantage that only two types of link members are required for the clamping device, the only difference between them being that the internal surface of the transverse bore is smooth in one type of link member and in the other has an internal thread for the headscrew. Such links can therefore be manufactured simply, since they only require one form of link member, with internal threads formed in the transverse bores of some of the link members.

According to another embodiment, assembley of a clamping device can be further facilitated by including in the set of linked members other members in the form of discs which have two parallel, substantially plane lateral surfaces not interrupted by longitudinal bores, each disc having a transvers bore without a thread. Since these additional link members do not have longitudinal bors, they may be as thin as required so that they can be used solely as spacers and by placing a number of such discs together, it is possible to maintain a required distance between linked mmbers equipped with longitudinalbores.

The invention will now be described by way of example, with reference to the drawing, in which:-

Fig. one is a perspective view of an external clamping device in accordance with the invention, holding together the parts of a broken bone;

Figure 2 is a side elevation of a joint member;

Figures 3 and 4 are top plans showing the plane lateral surface of the joint member of Fig. 2 in its first and second embodiments, respectively, interrupted by longitudinal bores for the rods;

Figure 5 is a side elevation of a headscrew;

Figures 6 and 7 are views corresponding to Figs. 2 and 3 of another joint member serving as a spacer disc;

Figure 8 is a sectional elevation seen in the direction of two connecting rods showing an arrangement of the external clamping device in which a bone nail makes an angle with the plane defined by the connecting rods;

Figure 9 is a top plan showing a modification of the joint member of Fig. 7;

Figure 10 is a top plan of a joint linking two connecting rods; and

Figures 11, 12 and 13 are views corresponding to Fig. 2 of three further embodiments of joint members.

The clamping device shown in its assembled state in Fig. 1 for holding together, i.e. fixing the parts 20, 21 and 22 of a bone comprises four bone nails 23 which have been passed through bores in the parts 20, 21 and 22 and the ends of which are joined to two connecting rods 26 by joints on links 24 and 25. The bone nails 23 on the one hand and the connecting rods 26 on the other lie in different but parallel planes. The device also comprises a bone screw 27 which has been screwed into the bone part 21 and the free end of which is connected by a joint on link 28 to the ends of two bone nails 29 which have their other ends joined to the connecting rods 26 by links 24.

The links 24 illustrated in Fig. 1 comprise two link members 31a and 31b which are illustrated in Figs. 2 to 4 and a headscrew 32 shown in Fig. 5. The link members 31a and 31b are square plates which are identical except for one feature which will be described below. These plates have two parallel plane lateral surfaces 33, 34 and two parallel longitudinal bores 35, 36. One bore 35 is of a diameter appropriate for receiving a bone nail 23 or 29 or a bone screw 27, which are all of the same diameter, so that the rods can easily be inserted in the bore 35. The bore 36 is of a diameter appropriate for receiving connecting rods 26 so that they can be easily inserted in the bore 36. The axes of the two bores 35 and 36 are parallel and extend in the direction of the plane external surface 33 and at a distance from it, which in both bores 35 and 36 is smaller by the same amount than the radius of the bore. Consequently, if a bone nail 23 or 29 or screw 27 is inserted in the bore 35 and a connecting rod 26 in the bore 36, each rod has a segment projecting by the same amount beyond the plane surface 33. Placed concentrically to the central axis 37 (Figs. 3 and 4) of the members 31a and 31b, which axis is perpendicular to the plane surface 33 and 34, the members have transverse bores 38 and 39, respectively, for a headscrew 32. The internal surface of the bore 38 is smooth while the internal surface of bore 39 and link member 31b has an internal thread for the thread 41 of the headscrew 32. This is the only difference between the members 31a and 31b. The links 24 and 25 are formed by the two link members 31a and 31b being placed with their lateral surfaces 33 in contact and held together by the screw 32 which passes through the bore 38 and is screwed into the bore 39. The two link members 31a and 31b can be pressed together with a required pressure by tightening the headscrew 32. The head 42 of the screw has an internal polygonal recess 43 to avoid sharp edges.

If one end of a bone nail 23 is inserted in the longitudinal bore 35 of link member 31a and a connecting rod 26 is inserted in the longitudinal bore 36 of link member 31b before the headscrew 32 is tightened, then a link 24 as shown in Fig. 1 is formed, in which the bone nail 23 and connecting rod 26 can

be fixed together at any angle to each other and at any axial position of the two rods relative to the link by tightening the headscrew 32, since tightening of the screw fixes the rods in their bores. When the headscrew 32 is released, the two rods can be shifted to any position relative to each other in a direction parallel to a plane perpendicular to the axis 37 without risk of the parts falling apart.

A link 25 is assembled from two link members 31a and a link member 31b. The two bone nails 23 are in this case inserted in the longitudinal bores 35 of the two outside link members 31a and 31b while the connecting rod 26 is inserted in the longitudinal bore 36 of the middle link member 31a. The uppermost member 31a of link 25 in Fig. 1 thus has its lateral surface 33 facing the lateral surface 34 of the second member 31a. All three members 31a and 31b are again firmly pressed together by tightening of the headscrew 32, whereby the bone nails 23 in the longitudinal bores 35 and the connecting rod 26 in the longitudinal bore 36 are fixed together. It should be noted that the three rods in the link 25 all lie in different planes parallel to the axis of the connecting rod 26. If only one bone nail 23 is used in this link, it may be arranged on one or other side of the connecting rod 26, but if the connecting rod 26 is inserted in the lowermost link member 31b and only one bone nail 23 is used, then the distance between the two rods 23 and 26, measured along the longitudinal axis of the headscrew 32, can be varied. This distance between the rods which are to be joined together can be even further varied for example, if instead of two link members 31a, a larger number of such link members is used to form the link.

Fig. 8 shows how by using a link composed of several members, e.g. a four-membered link 44, it is possible to arrange a bone nail 23 at an angle 45 for example, to the plane 46 defined by the connecting rods 26. It can be seen that the distance of the bone nail 23 from the plane 46 increases with increasing distance from the second link 47 so that by displacement of the link 44 along the nail 23, the distance from the link 47 can always be adjusted so that a link 44 can be assembled from the link members 31a and 31b at any required angle of inclination 45 of the nail 23. Fig. 8 also shows that when using only two link members 31a and 31b to form the link 44, the nail 23 in this arrangement is at an angle to the plane 46. Fig. 10 shows how a set of only two types of link members 31a and 31b described above can be used to extend the length of a rod, in particular a connecting rod 26, in any direction by means of a second connecting rod 26a. In this case, one connecting rod 26 is inserted in the bore 36 of a link member 31a and the other connecting rod 26a is inserted in the bore 36 of a second link member 31b, and the two members are releasably held together by the headscrew 32.

To be able to increase the range of variation of the distance between the rods held together by a link measured in the direction of the longitudinal axis of the headscrew 32, the set of link members 31a and 31b described above may be supplemented by additional link members 48. One such link member 48 is shown in Figs. 6 and 7. It comprises a circular disc, e.g. 1 mm in thicknes, having a central transverse bore 49 corresponding to the bore 38 of the link member 31a. This link member 48 is intended merely as a spacer disc by means of which the distance between two link members 31a, 31b can be varied over quite a wide range, for example by inserting the required number of link members 48 to produce a given distance between the two link members 31a, 31b. These link members 48, however, also provide another advantage. When a link 24 has been tightened, the rods seated in the various link members make only point contact with each other if they are arranged at an angle, so that the surfaces of the rods are liable to lose its smoothness after prolonged use and moreover, the full clamping effect is not retained. If on the other hand a link member 48 is inserted between two link members 31a and 31b, then that part of the rod in the adjacent link member 31a or 31b which projects from the lateral surface 33 makes full surface contact with the adjacent link member 48 so that a better clamping effect is obtained and the rod suffers less damage. A link 47 assembled in this manner is shown in Fig. 8.

Fig. 9 shows another link spacer member 51 which is substantially identical to the link member 48 but sufficiently thick that its bore 52 may have a thread for the headscrew 32. Such a link member 51 opens up the possibility of providing another simple set of link members for the clamping device, again consisting of only two different members. Any link can be assembled from the link members 51 and the link members 31a although the link members 31a must then also serve as spacer discs, as already described. Since in such a case the lateral surfaces 33 can always lie in contact ither with the lateral surface of the member 51 or with the lateral surface 34 of a member 31a, no members 48 are required for obtaining a better clamping effect, although the possibility of using such members 48 with this set of link members is not excluded, and link members 51 having a bore 49 without thread may also be used.

The link members in the embodiments described above for assembling an external clamping device may also be supplemented or replaced by link members 53 and 54 shown in Figs. 11 and 12. The link member 53 has the same structure as a link member 31a or

31b except that, instead of two different longitudinal bores 35 and 36, it has two identical longitudinal bores 35. The link member 54 has two longitudinal bores 36 for the connecting rods 26. The link members 53 and 54 multiply the possibilities of arranging the rods.

That the invention also enables simple links to be formed from differently shaped link members can be seen from the embodiment of a link 55 illustrated in Fig. 13, which consists of link members 56 and 57 held together by a head screw 32 (not shown). Both link members 56 and 57 have only one plane lateral surface 33, the surface 33 of member 56 having a longitudinal bore 36 for the connecting rods while the surface 33 of member 57 has a longitudinal bore 35 for a bone nail or screw. In addition, the member 56 has a smooth transverse bore 38 and the member 57 a threaded bore 39. If each link member 56, 57 is provided in two varieties, namely one with a smooth transverse bore and the other with a threaded bore, such a set of four different link members can be used to join any two rods together in any manner required.

CLAIMS

1. An external clamping device for holding together bones or bone parts with rods formed as bone nails, bone screws or connecting rods, held together by multi-membered linked which have bores for the rods, and in which bores the rods can be fixed, wherein (i) a set of link members of first and second types is provided to form several links, (ii) each link member has at least one flat external surface, at least one longitudinal bore for a rod, the axis of which bore is parallel to and along the flat external surface at a distance therefrom which is less than the radius of the bore, and a transverse bore which is substantially perpendicular to the flat external surface and (iii) a link comprises a link member of the second type and at least one link member of the first type which can be pressed together by clamping means with their flat external surfaces facing each other so that rods inserted in the longitudinal bores have their circumferential surfaces partly projecting from the flat lateral surfaces of the link members and are clamped tightly in the longitudinal bores.

2. A device according to claim 1 wherein the internal surface of the transverse bore of a link member of the first type is smooth and the internal surface of a link member of the second type is threaded to receive a single clamping means in the form of a single headscrew.

3. A device according to claim 1 or claim 2, wherein two parallel longitudinal bores are provided in the flat lateral surface, which bores are equidistant from the transverse bore on different sides thereof.

4. A device according to any preceding claim, wherein at least in some of the link members, one longitudinal bore is designed to receive a bone nail or a bone screw and the other longitudinal bore is designed to receive a connecting rod.

5. A device according to claim 4, wherein the distances of the axes of the two longitudinal bores from the flat lateral surface are less than their radii by equal amounts.

6. A device according to any of claims 3 to 5, wherein in some of the link members, both longitudinal bores are designed to receive bone nails or screws.

7. A device according to any of claims 3 to 6, wherein in some of the link members both longitudinal bores are designed to receive connecting rods.

8. A device according to any preceding claim, wherein at least some of the link members are plates having two parallel flat lateral surfaces.

9. A device according to any preceding claim, wherein the set of link members also includes link members which are in the form of discs having two parallel and substantially flat, uninterrupted lateral surfaces, each disc having a transverse bore with or without thread.

10. A device according to any preceding claim, wherein each link member is centrally symmetrical about a central axis extending perpendicularly to the flat lateral surface, is round or square, and the transverse bore is concentric with the central axis.

11. A device according to any of claims 2 to 10, wherein the headscrew has a polygonal recessed hole in its head.

12. An external clamping device for surgical purposes for holding together bones or bone parts with rods which are formed as bone nails, bone screws and connecting rods and held together by links in which the link members are in surface contact with each other along plane external surfaces and are held together by a screw bolt engaging in transverse bores, and have longitudinal bores for the rods, which longitudinal bores extend parallel to the plane external surfaces and are intersected by them, the longitudinal axis of the longitudinal bore for a connecting rod and the longitudinal axes of the longitudinal bores for the bone nails and screws being situated at a distance from the plane external surfaces which distance is only slightly less than the radius of the longitudinal bore, and in which links the screw bolt is in the form of a headscrew, and a set of link members comprising for each link one link member in which the transverse bore has an internal thread for the thread of the headscrew.

13. An external clamping device for holding together bones or bone parts, constructed and arranged substantially as herein described and shown in the drawings.

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